The PHENIX Multiplicity Vertex Detector

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PHENIX Collaboration Meeting
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MVD Overview

Physics Goals:

* Charged particle multiplicity
* $d^2N/d\eta d\varphi$
* Centrality trigger at LVL-1
* Collision vertex position ($\sigma < 2mm$)

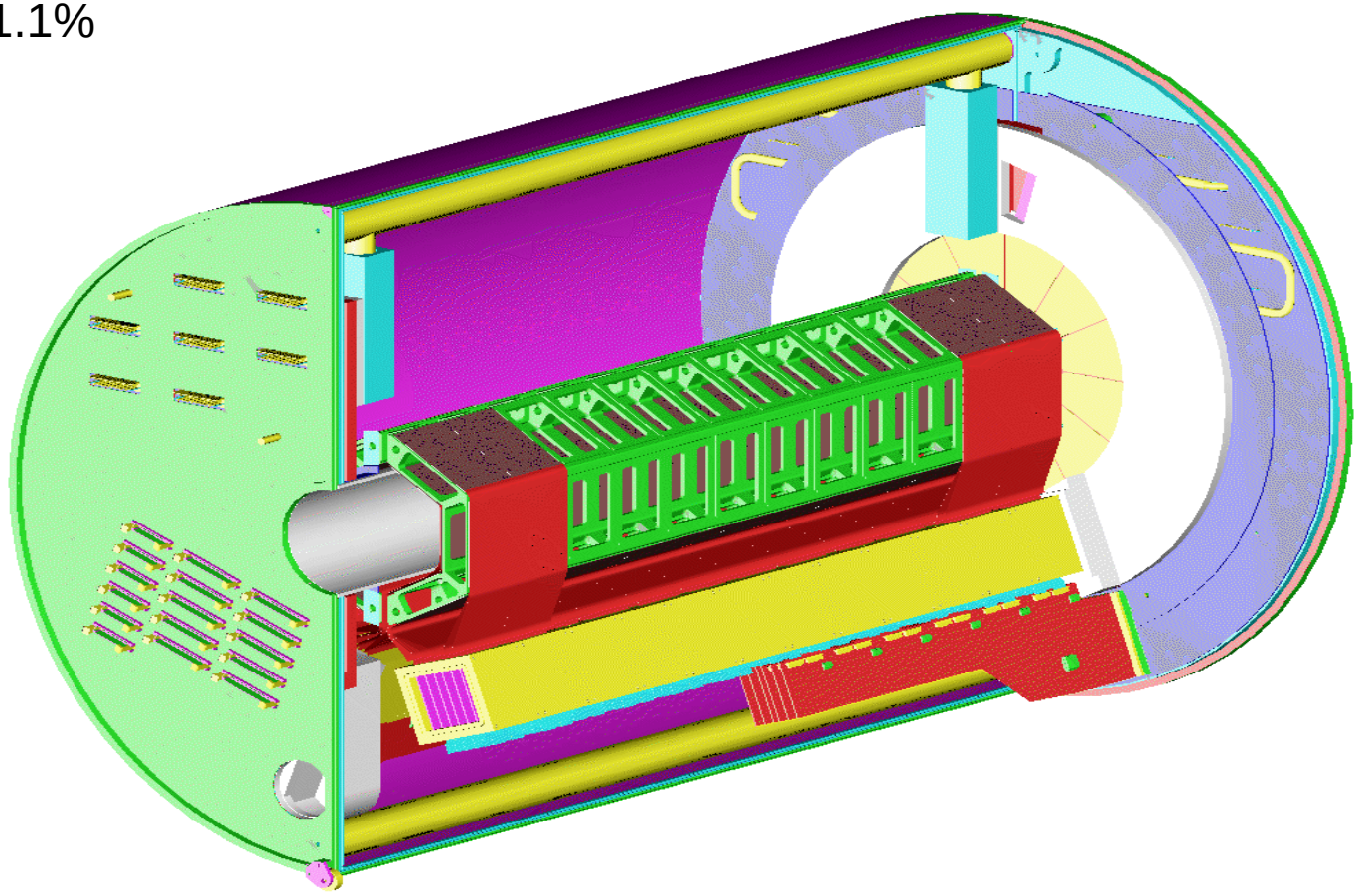
Design Criteria:

* Large rapidity coverage ($\Delta\eta = 5$)
* Good azimuthal coverage & granularity
* Minimum material in electron arm acceptance

Key parameters:

* Clamshell design - mounts to magnet pole faces
* Silicon strip barrels (200μm pitch, 64cm length)
* Silicon Pad endcaps at +/- 35cm
* Radiation length < 1% for 2 silicon layers
* Weight approximately 28 pounds
* 35K Total channels
* Electronics are air-cooled and motherboard is liquid cooled

Clamshell design - mounts to magnet pole faces.
Inner and outer barrels of silicon strip detectors, 200μm, 64cm length
Silicon pad endcaps @ +/- 35cm
Rad length ≈ 1.1%
Weight < 30lb



Strip electronics at bottom - Multichip Module
256 channels/detector
Channel count = 34,816

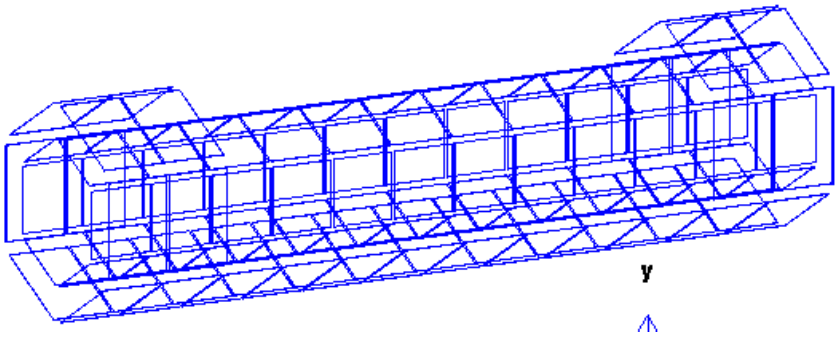
MVD Subsystem

Project Leader & Detector Council Member: J. Simon-Gillo (LANL)
Mechanical Coordinating Physicist: J. Simon-Gillo (LANL)
Electronics Coordinating Physicist: J.P. Sullivan (LANL)
Lead Mechanical Engineer: J. Boissevain (LANL)
Lead Silicon Design and Electronics Engineer: S. Hahn (LANL)
Lead Integrated Chip Design Engineer: C.L. Britton (ORNL)
Lead Interface Module Engineer: N. Ericson (ORNL)
Systems Integration Engineer: J. Boissevain (LANL)
Lead MCM Engineer: G. Smith (LANL)
Lead MCM Designer: G. Richardson (LANL)
Simulation Computing: H. van Hecke (LANL)
Off-line Computing: J.P. Sullivan (LANL)
On-line Computing: H. van Hecke (LANL)
Database Coordinator: H. van Hecke (LANL)
Construction Manager: M. Bennett (LANL)

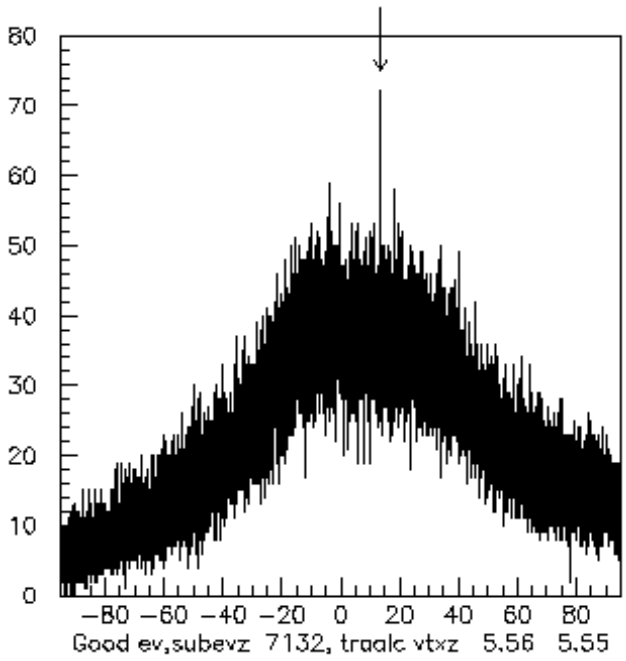
Institutions: Los Alamos National Laboratory, OakRidge National Laboratory, University of California at Riverside, Yonsei University, University of Alabama at Huntsville.

3D Vertex Finding in the MVD

Hubert van Hecke, LANL



The MVD Barrel showing only the silicon panels, arranged in 6 sectors and 2 concentric barrels.
Strips are perpendicular to z.
Note the missing panels in the central top and side regions.

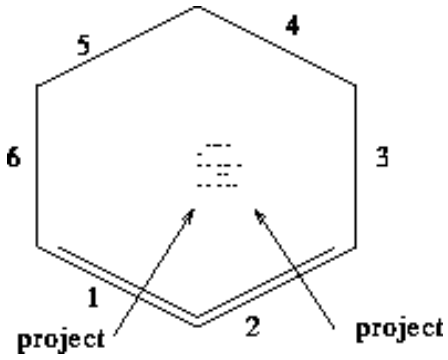


First, the Z vertex is found by drawing lines, sector by sector, through each of the outer barrel hits and each of the inner barrel hits, and projecting these "tracks" onto the z axis.
The Z-vertex is found by locating the maximum in the distribution of these projections.

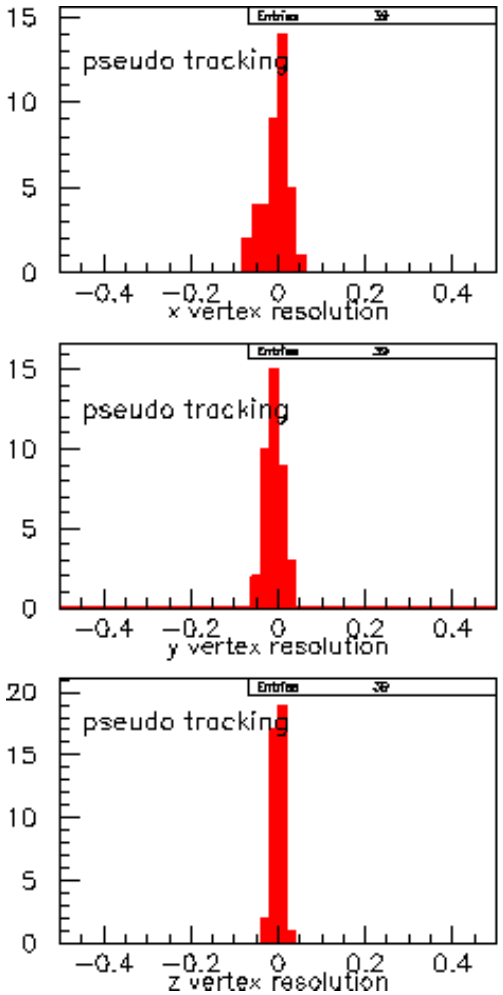
The arrow indicates the true vertex position at 5.56cm. The pseudo-tracking method found the vertex at 5.55cm.

New: 3D Capability

Hubert can Hecke, LANL



Next, the X,Y of the vertex can be found by placing a plane at the found Z position, perpendicular to the Z axis. Using only the fully populated bottom sectors, project tracks into this plane, and again locate the maximum.



These are the 3D vertex finding resolutions in X, Y and Z. The scale is in cm, so the typical resolution is better than 200um sigma.

In this particular run, the mean beam position was offset from the nominal z-axis by a full 2mm in X and 2mm in Y.

With the new 3D capability, the vertex-finding efficiency is now independent of the mean transverse beam offset.

Recent Mechanical Progress

Significantly increased in people-power

Final Mechanical Design Review
Safety Review

Full-scale prototypes of ALL mechanical components
    Including magnet and nose-cone mockup

Completed Design of cooling systems
    Air cooling for MCM and silicon
    Liquid Cooling for Motherboard

Testing production silicon strip detectors

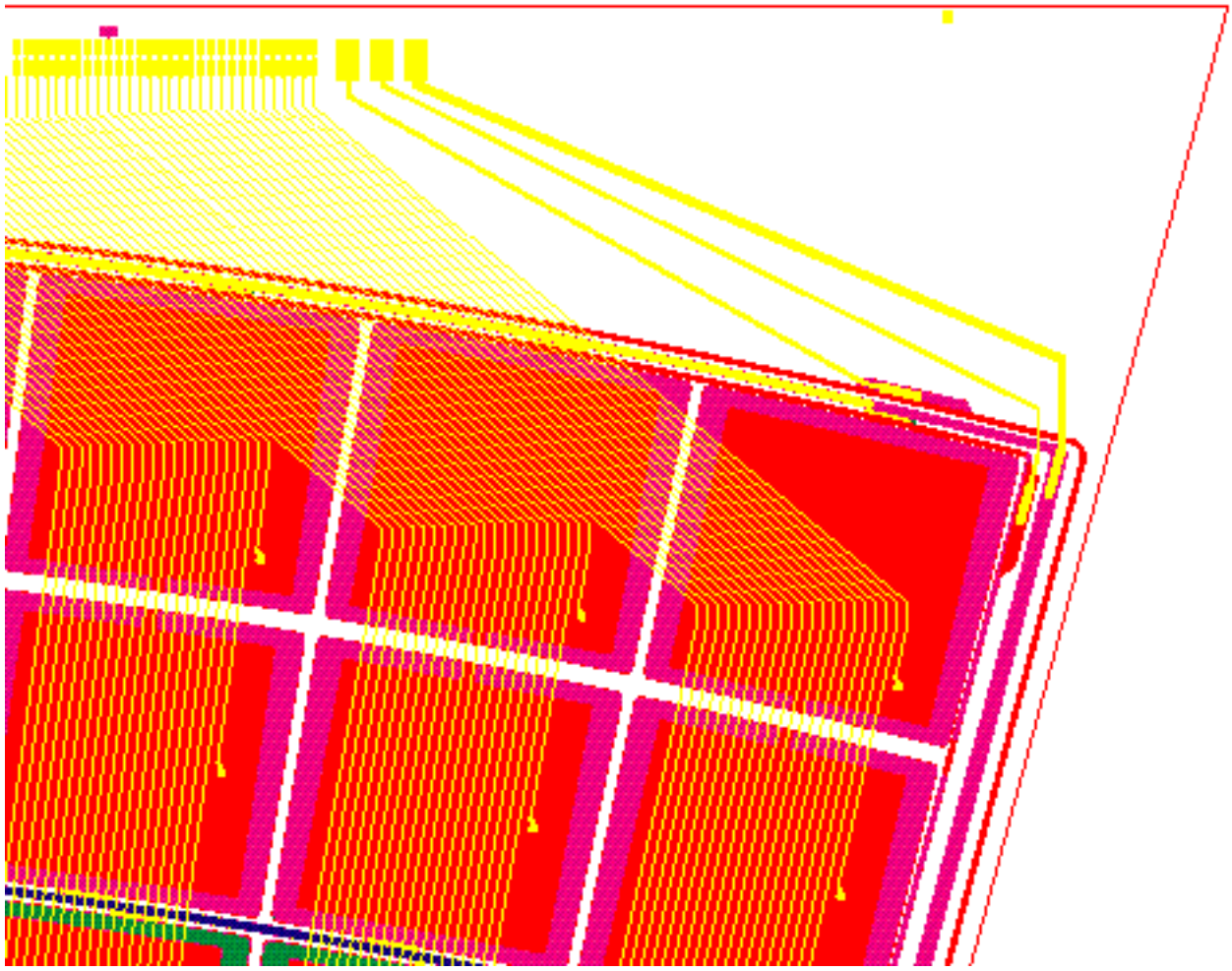
Technology choice on pad detector

Rohacell cage production factory at UCR
Kapton Cable testing factory at UAH

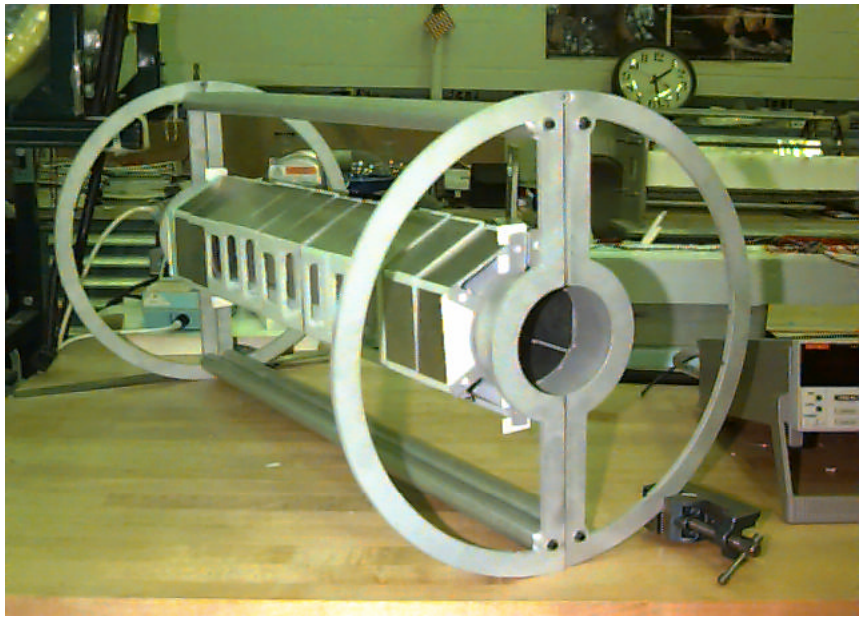
Final production silicon contract in place

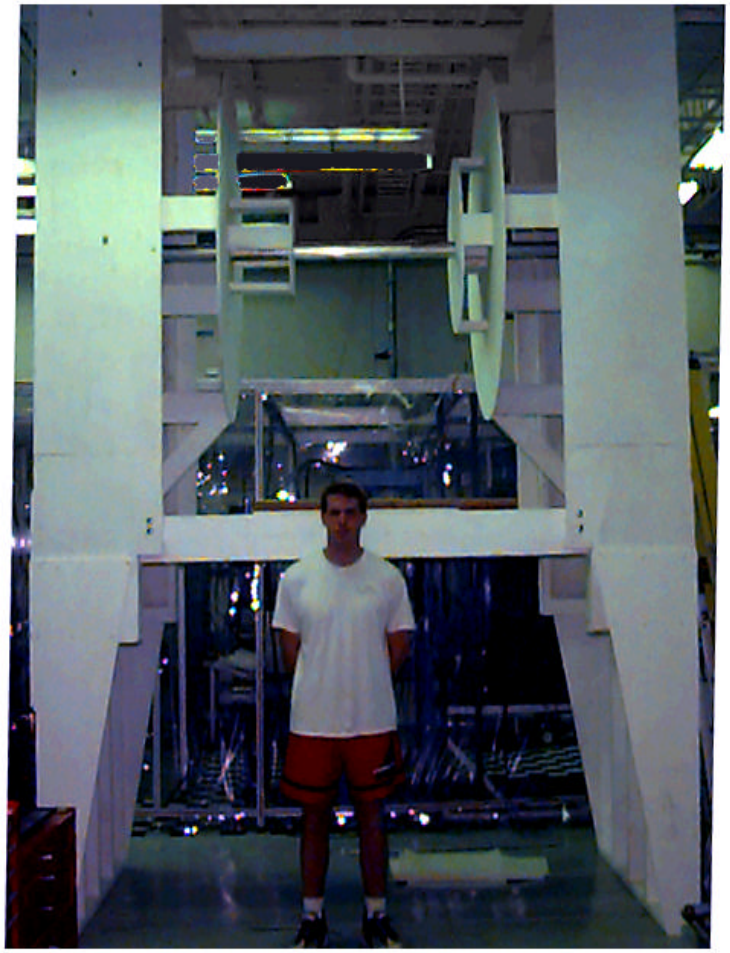
Setting up Assembly and construction lab at LANL

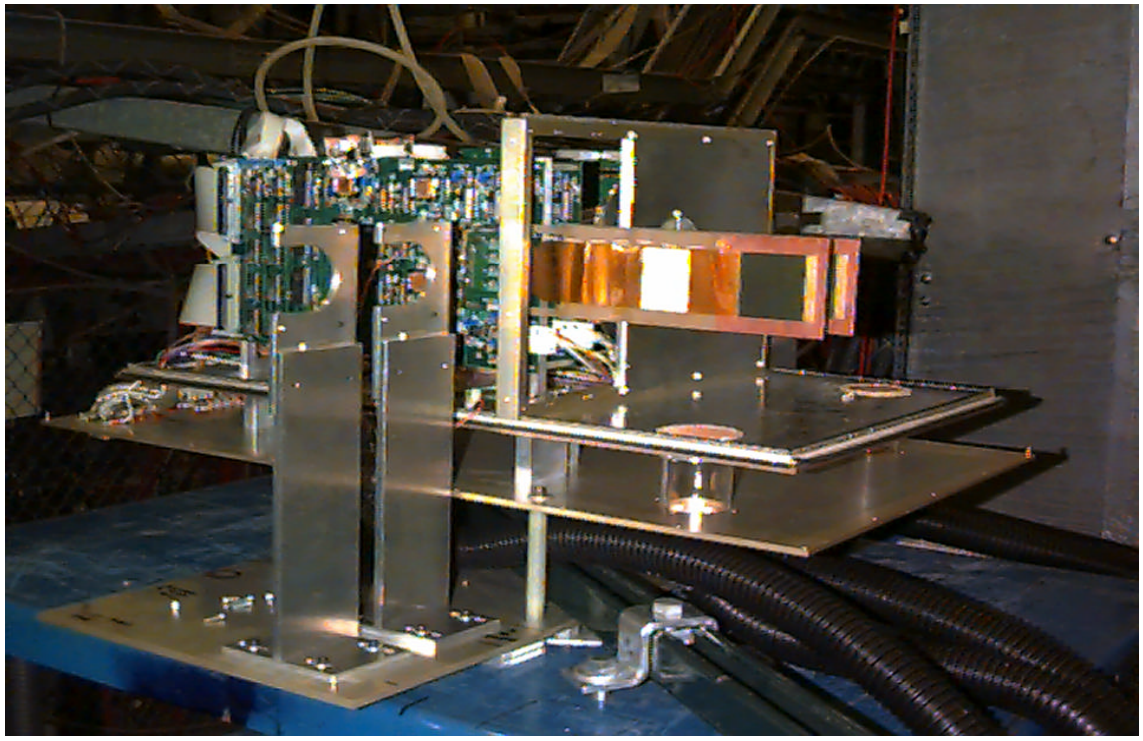
Double Metal Pad Detector



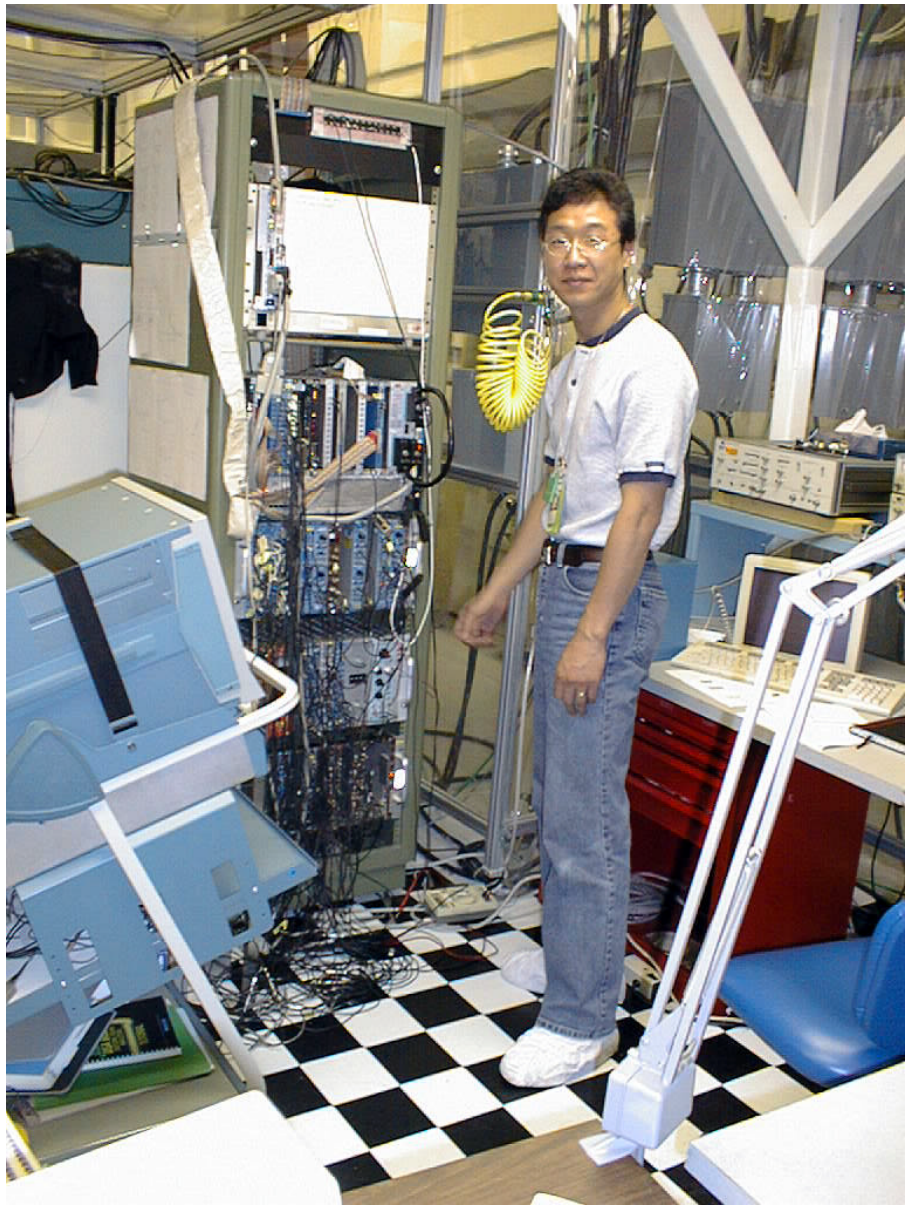
* Eliminates specialized kapton cable
* Reduces wirebonding
* Facilitates detector probing
* Facilitates assembly, handling
* Increases yield
* Sequential readout

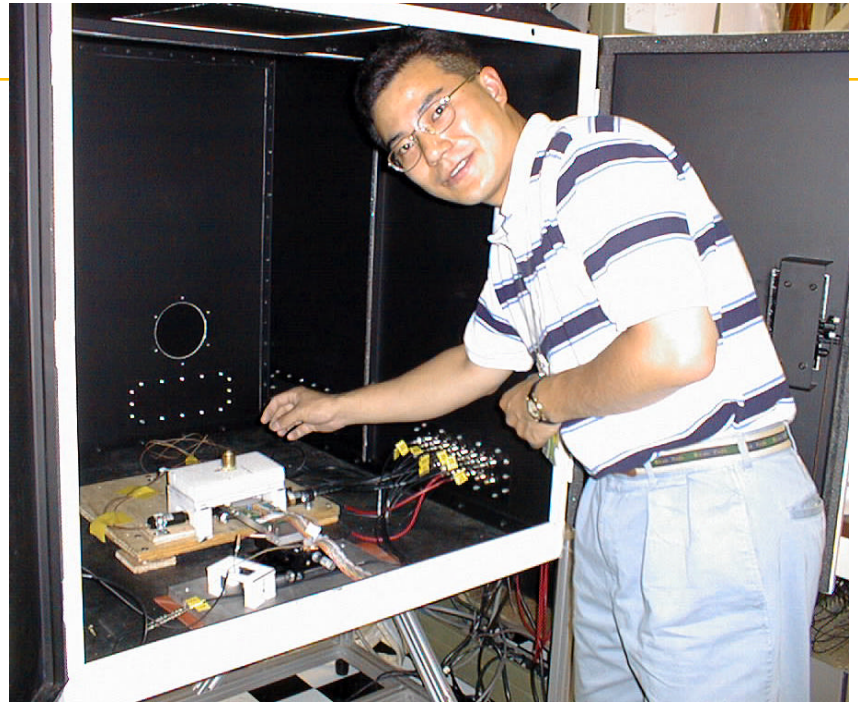


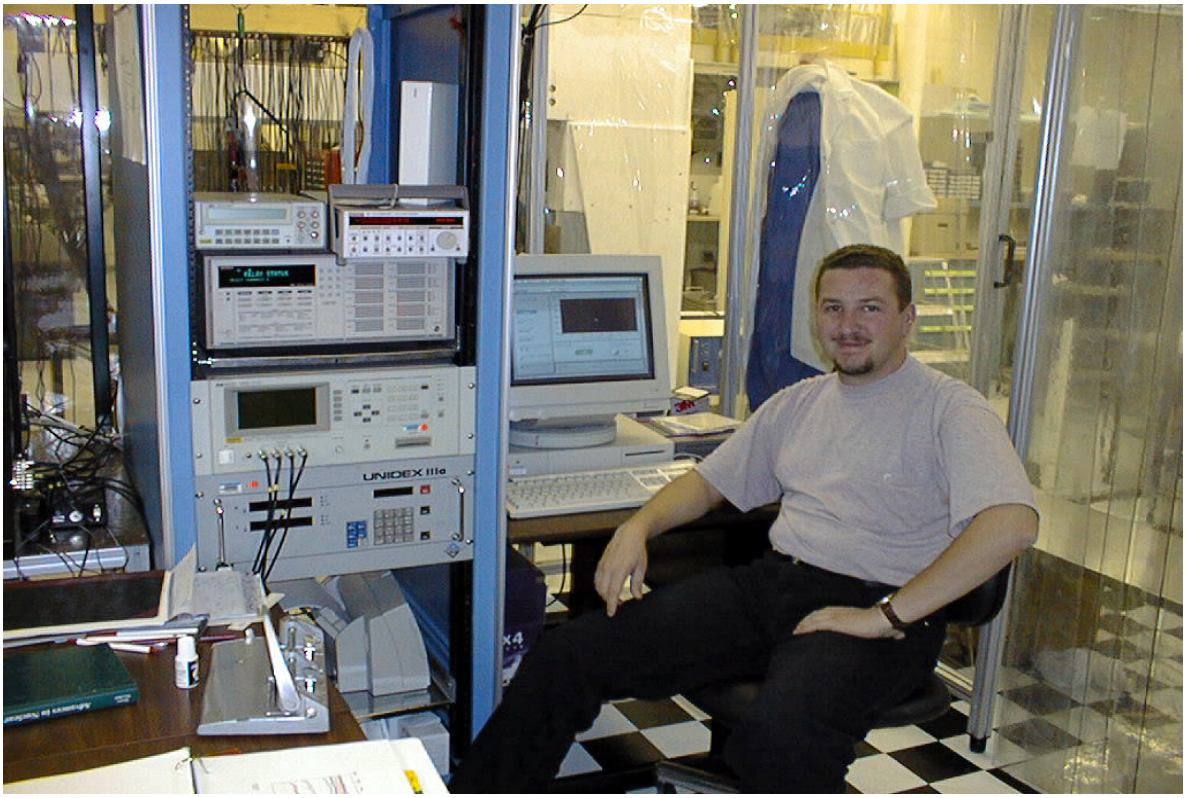


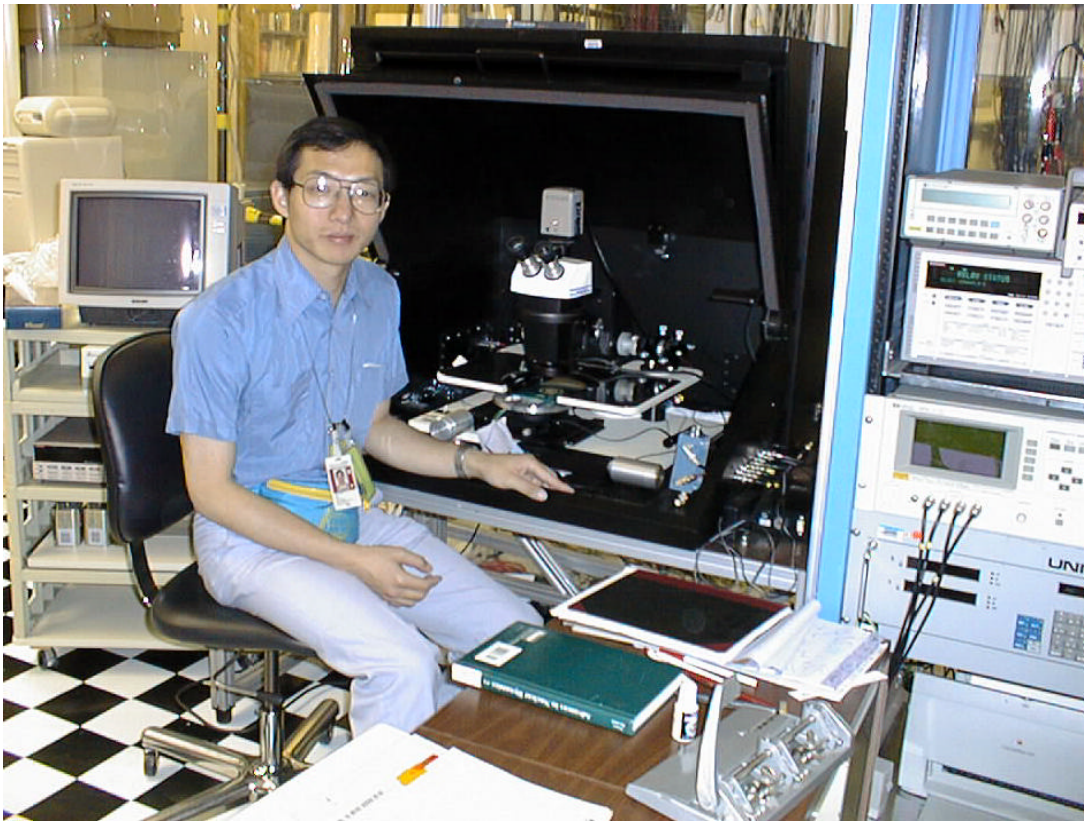


Jehanne Simon-Gillo, *LANL*






UNIDEX IIIe



Recent Electronics Progress

Design of electronic die complete
- AMUADC in fabrication
- Switch from ORBIT to HP for preamp - KGD
- Preamp design review in Dec - fabrication
- Xilinx 4010 in fabrication

Custom ASIC Known Good Die Tests defined and out for bid

Design of interface modules complete - at layout

Motherboard design complete - at layout
Power Communication board design complete - layout next
All connectors and cables identified - started procurement

Pre-prototype MCM procurred and being tested
Final MCM layout complete - fab run under negotiation

Setup of "chain test stand" underway - needed to test MCM

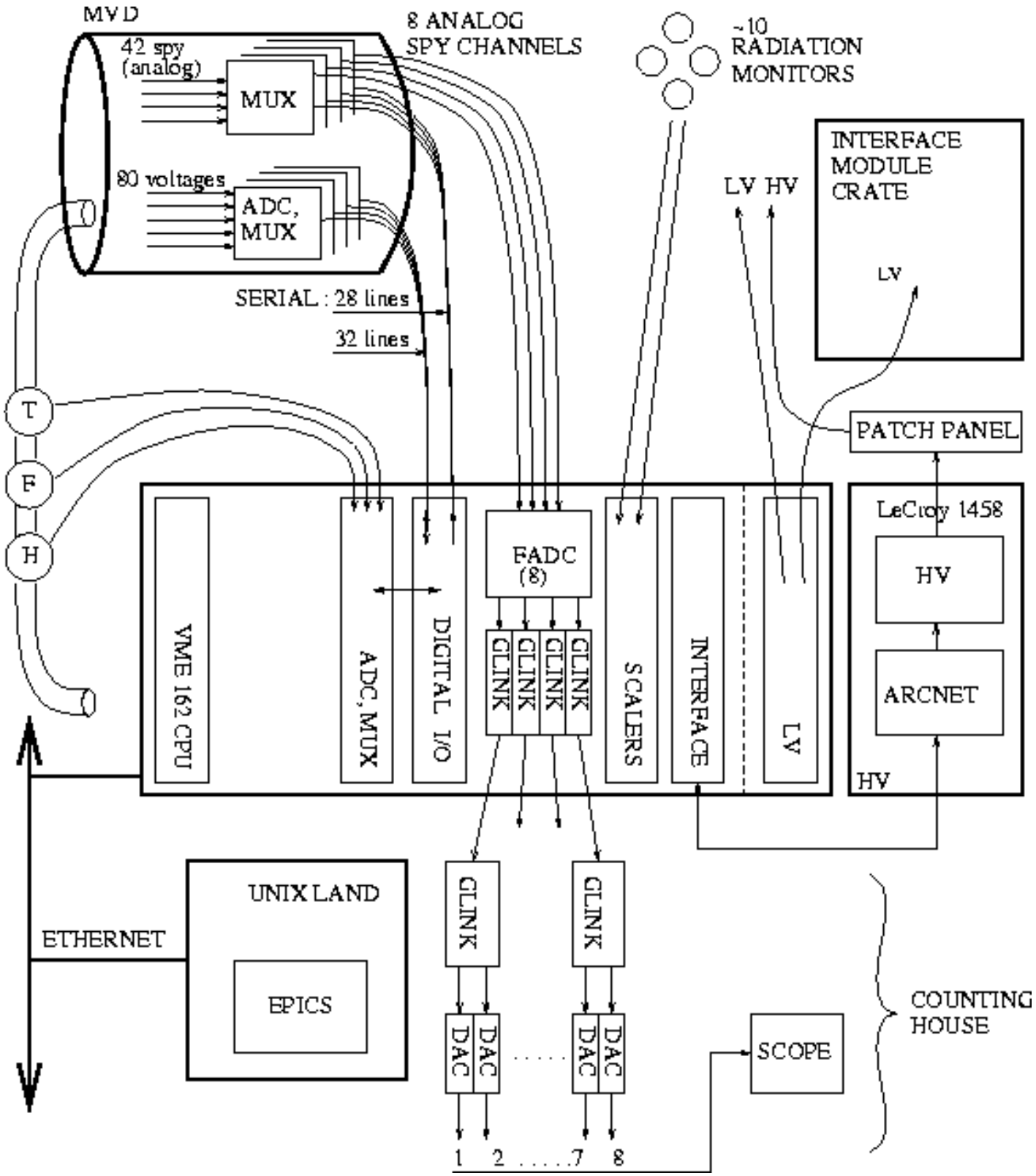
Final MCM

Design at LANL/NIS
Lead Engineer - Gary Smith
Lead Designer - Gary Richardson

256 channels/MCM
4 preamp, 4 AMUADC, 2-4010, opamp, T sensor per MCM
Trace pitch = 54 μm
line width = 43 μm
I/O pad pitch = 150μm

4 layers + base metal

M0 = 0.1μm titanium/0.3μm Cu/4μm Cu
M1 = Signals, all connections off IC chips
M2 = Bus lines
M3 = Power lines
M4 = surface mount components


MVD
42 spy (analog)
MUX
80 voltages
ADC, MUX
8 ANALOG SPY CHANNELS
~10 RADIATION MONITORS
INTERFACE MODULE CRATE
LV
LV HV
SERIAL : 28 lines
32 lines
T
F
H
PATCH PANEL
VME 162 CPU
ADC, MUX
DIGITAL I/O
FADC (8)
GLINK
GLINK
GLINK
GLINK
SCALERS
INTERFACE
LV
LeCroy 1458
HV
ARCNET
HV
ETHERNET
UNIX LAND
EPICS
GLINK
GLINK
DAC
DAC
DAC
DAC
SCOPE
COUNTING HOUSE
1 2 . . . . 7 8

Some Future Key Milestones

MECHANICS

Pad Detector Design Complete	7/97
Final Mechanical Design Review	7/97
Test Vertex Detector Assembly	3/98
All Detectors Tested	6/98
Detector SubAssemblies Tested and Complete	11/98
MVD Assembly Complete	2/99
MVD Operational	4/99

ELECTRONICS

Moth, Pow/Com Tested & Complete	4/98
Interface Modules Complete	5/98
Chip Fabrication Complete	3/98
Full chain test MCM Pre-production	4/98
MCMs Complete	7/98
Electronics Complete	7/98

MVD Posters

Ju Hwan Kang for the MVD Collaboration
"A Multiplicity-Vertex Detector for the PHENIX Experiment at RHIC"

David Jaffe for the MVD Collaboration
"Results of the PHENIX MVD Prototype Detector and Electronics Beam Test"

Sangyeol Kim for the MVD Collaboration
"A Beta Source Test Stand for Measuring Crosstalk in MVD Silicon Pad Detectors"

Guanghua Xu for the MVD Collaboration
"The Design of Silicon Detectors in the PHENIX Multiplicity Vertex Detector"